sides lie in their lee. Ascensional expansion of the air causes cooling and precipitation; the latter which is somewhat greater to leeward than to windward of the crests and greatest beside the greatest altitude, so that the amounts collected fall in the order named. Were the wind always in the east, however, there would seem to be no reason to expect the high windward (east) side to have a smaller precipitation than the low leeward (west) side. The occasional northeast wind, however, makes the east side windward of the west side's ridge.

Perhaps the rains of 1898 that gave a record of 115 inches at Brothersons were accompanied by unusually high winds.

MONTHLY STATEMENT OF AVERAGE WEATHER CONDITIONS FOR FEBRUARY.

By Prof. E. B. GARRIOTT.

The following statements are based on average weather conditions for February, as determined by long series of observations. As the weather of any given February does not conform strictly to the average conditions, the statements can not be considered as forecasts:

February is one of the stormiest months of the year along the transatlantic steamer tracks of the North Atlantic. The storms begin with east to south gales, which, in the case of westward bound steamers, quickly shift to westerly. Ice is rarely encountered as far south as the steamer routes in February, and fog is not frequent over and near the Banks of Newfoundland. In the tropical regions of the Atlantic storms seldom appear in February. On the north coast of western Cuba, however, and over the Gulf of Mexico high north winds, with decided falls in temperature, are not uncommon in February.

In the Atlantic coast districts and the Lake region of the United States the severer storms of February come from the middle-west and southwest. Well-marked storms of this type begin with high northeast winds and snow, and as they progress the wind shifts to west and northwest, with a cold wave. On the Great Plains and in the Rocky Mountain and Plateau districts February weather is usually dry and cold. As during January, however, this entire region is subject to occasional cold waves of great severity, which, with snow and high winds, sweep southward from the British Possessions in the northwest, and sometimes reach the Rio Grande and northern Mexico.

In the Pacific coast districts of the United States the season of rains and occasional strong gales continues through February.

Frost is liable to occur in any part of the United States in February. In the Gulf coast districts and in central and northern Florida the likelihood of severe freezes in February is less than for the preceding month.

THE RELATION BETWEEN THE LEVEL OF GREAT SALT LAKE AND THE RAINFALL.

By SIMON F. MACKIE, dated Salt Lake City, February 20, 1901.

The changes of level during past ages in the lake, whose remnants are known as Great Salt Lake, are matters that have been much studied from a geological point of view. The present paper relates to those changes which have occurred within a recent period and their relation to meteorology.

The drainage basin of this lake, shown in fig. 1, has an area of about fifty-four thousand square miles. How much water enters the lake from, by far, the larger portion of this area, is problematical, for all its visible affluents rise in the Wasatch or Uintah mountains. These affluents are few in number. The Jordan, Weber, and Bear are good sized rivers; Farmington Creek is a small stream; and besides these there are only a few streams from springs near the shores of the lake.

The annual evaporation from a free water surface in this vicinity is placed at about 8 feet per annum. This evaporation takes place from the whole surface of the drainage basin, as well as from the surface of the lake itself, although of course the evaporation from the soil is less than from the lake. Doubtless the rainfall in the mountains is larger than in the valleys; but, other things being equal, the evaporation is also greater. The evaporation from snow or ice is evaporation from a free water surface, as distinguished from soil, and much of the winter snowfall evaporates without melting, so that additional precipitation in the mountains is offset by additional losses.

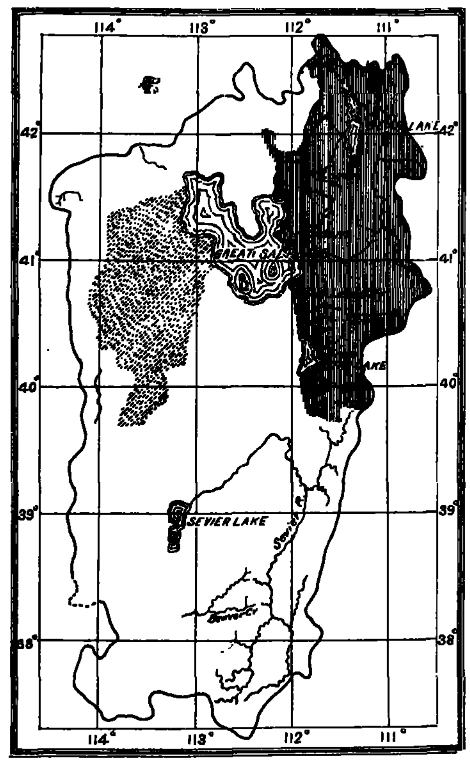

FIG. 1.—Drainage basin. Visible water supply, heavy shading; wet soil in light shading.

The actual drainage basin from which Great Salt Lake receives its visible supply of water is shown by the dotted line in fig. 1. Assuming an available rainfall of 16 inches per annum, it would require an area six times as large as the lake to supply its annual loss by evaporation. But if the visible drainage basin is apparently too small to supply the loss by evaporation, it would possibly be a mistake to suppose that no part of the supply comes from other portions. West of Great Salt Lake there is a tract of country considerably larger than the lake, in which the level of the underground water is, for practical purposes, always at the surface of the soil. This tract, if it is remembered rightly, slopes upward from the shores of the lake, until, at its western limit, it is about 100 feet higher. To the southwest Sevier Lake represents the lowest point of a drainage basin of large extent. Sevier Lake is higher than Great Salt Lake, and from it a tongue of wet soil extends northerly. So far as known, no attempt to map these wet lands has hitherto been made, and in fig. 1 is shown what is believed to be their probable boundary. The problem of the actual sources of the water supply of Great Salt Lake is therefore complex, especially as the wet area to the west receives the drainage of but one or two small mountain streams.

The changes in the volume of water in Great Salt Lake, within the period in which it has been known, are great, The present average depth of this lake is placed at 13 feet. Within a period of fifty years it has been as low as it is now, and it has also been 13 feet higher. The shores are flat, and any rise is accompanied by a considerable increase of area; so that the present volume of water in the lake is probably less than fifty per cent of what it was in 1869.

The Mormons settled in Salt Lake Valley in 1847 and at once commenced to resort to irrigation for farming purposes. In 1848 5,153 acres were irrigated, and from that time until now the area has increased. At present all the waters of the affluents of Great Salt Lake are, as far as possible, diverted for purposes of irrigation. The following will serve as an example, showing how far this diversion of water for irrigation has been pushed. South of Great Salt Lake lies Utah Lake which empties into it through the Jordan River. The Provo River, which rises in the Uintah Mountains, is the principal affluent of Utah Lake. All the waters of the Provo River are more than once diverted, in Utah County, for irrigating purposes. All the waters of the Jordan River are diverted into various irrigating canals shortly after it leaves Utah Lake, and all the seepage water in this river is again diverted lower down more than once. Of course, the diversions mentioned only occur during the irrigating season; but, in addition to all this, it is attempted to impound the water flowing into Utah Lake in the winter and spring for use during the following summer.

This use of water for irrigating purposes, great though it is, cannot, however, be regarded as having the dominant influence on the level of Great Salt Lake. A diagram of the levels of this lake since 1850 is shown in fig. 2. During the thirty years between 1850 and 1880 larger and larger quantities of land were irrigated, more and more water was used, yet despite this large and continually increasing drain, the volume of the water in the lake doubled itself. It would be absurd, therefore, to assume that the diversion of its visible affluent waters is the dominant cause of the fluctuation in the level of Great Salt Lake, and this conclusion becomes stronger when it is recalled that lands when first irrigated require more water than later, so that, with a limited supply of water, the area of the irrigable land keeps increasing.

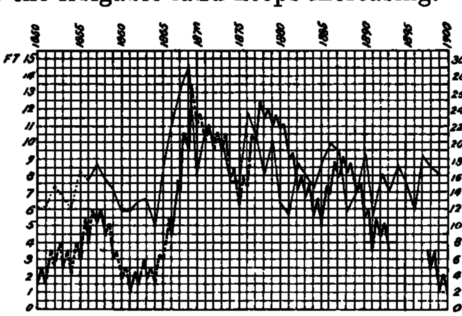

FIG. 2.—Rainfall (light lines) and lake levels (heavy lines).

If the use of water for irrigating purposes cannot, *per se*, account for all the changes of level, then it will hardly be questioned that the rise and fall of Great Salt Lake is the concrete resultant of complex climatic forces, whose study from this point of view is important.

A comparison between the level of Great Salt Lake and the annual precipitation in Salt Lake Valley has been made, with the result shown in fig. 2. In reference to this comparison it has been said, by those adducing it, "there is a general agreement between precipitation and the lake variation," and this may well be regarded as a favorable summing up. It requires, however, but little consideration to see that this comparison is hasty and illogical in principle.

Assume that all the precipitation were collected in a rain gage in which it could accumulate for an indefinite period, without sustaining any loss whatever, and that by means of a pencil, moved by a float in this gage, an automatic record of the precipitation were kept on a continuously moving sheet of paper, and consider the nature of the trace on the paper thus obtained. Below is given the rainfall in Salt Lake City from the observations taken by the United States Weather Bureau during the month of November, 1900:

Date.	Precipitation, in inches.	Date.	Precipitation, in inches.	Date.	Precipitation, in inches.
Nov. 1...	0.12	Nov. 11..	0.00	Nov. 21..	0.15
Nov. 2...	0.00	Nov. 12..	0.00	Nov. 22..	0.01
Nov. 3...	0.00	Nov. 13..	0.00	Nov. 23..	0.17
Nov. 4...	0.00	Nov. 14..	0.00	Nov. 24..	0.00
Nov. 5...	0.00	Nov. 15..	0.00	Nov. 25..	0.00
Nov. 6...	0.00	Nov. 16.	0.00	Nov. 26..	0.00
Nov. 7...	0.00	Nov. 17..	0.55	Nov. 27..	Trace.
Nov. 8...	0 00	Nov. 18..	0.12	Nov. 28..	0.00
Nov. 9...	0.00	Nov. 19..	0.21	Nov. 29..	0.00
Nov. 10..	0.00	Nov. 20..	0.07	Nov. 30..	0.00

Fig. 3 shows an approximation to what would have been the pencil trace if an automatic record like that referred to had been kept.

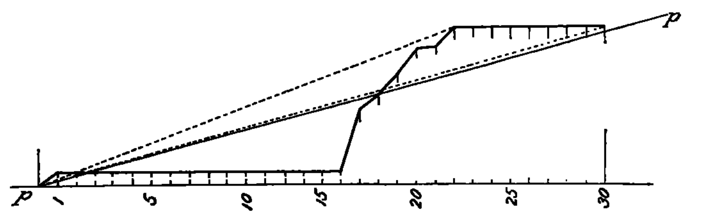

FIG. 3.

Referring to fig. 3 it will be seen that when there is no precipitation this trace is a horizontal line, while as soon as it begins to rain this line commences to rise, and continues rising so long as it rains. It has *ex necessitate*, been assumed that the precipitation was uniform throughout the whole period in which it is reported to have occurred. This assumption is inaccurate, an absolutely correct representation requiring that the ascending straight lines in fig. 3 be replaced by more or less complex curves; but the error thus introduced does not affect the general idea of the form of such a quasi automatic pencil trace, or the conclusions to be drawn from it. This quasi automatic trace is evidently an automatic integration, the ordinates to the curve, giving the total rainfall from the commencement of the record to the date of the corresponding ordinate. If, therefore, it be desired to show upon such a quasi automatic record the position of a line representing the mean precipitation for any period, all that is necessary is simply to draw a straight line from the origin through the summit of the terminal ordinate of the period for which the average is desired.

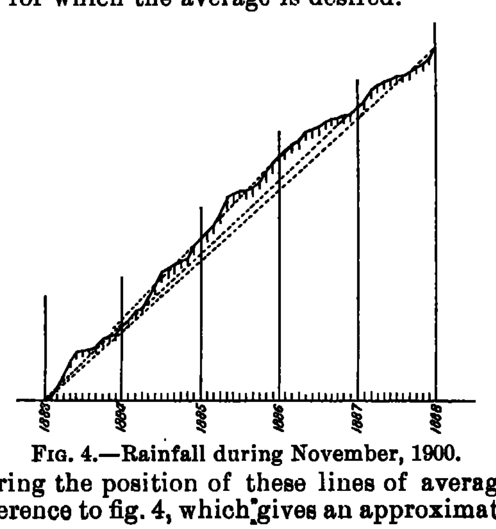

FIG. 4.—Rainfall during November, 1900.

Considering the position of these lines of average precipitation, reference to fig. 4, which gives an approximate diagram of the rainfall at Salt Lake City, for a few years, constructed upon the assumption that the precipitation in any month occurred uniformly throughout that period (but otherwise similar to fig 3) shows that they oscillate about the true position of the line of mean precipitation, according to whether the terminal period is wetter or drier than the true average, rising above it if wetter, falling below it if drier. The amplitude of these oscillations will diminish as the period of observation lengthens, but the oscillation does not vanish until the period of observation becomes infinite, and even a close approximate to the true mean precipitation can only be obtained after long-continued observations. Very possibly the finding of a close approximation to the mean precipitation might be facilitated by a resort to the mathematical theory of probabilities; but this is a question foreign to present purposes.

Reverting to the automatic trace previously described, compare it with what was done in preparing the rainfall line in fig. 2. In the first place, the continued process of mechanical integration, accomplished by the hypothetical automatic record is from time to time arbitrarily interrupted; in other words, the rainfall from one first of January to the next is added up, the total stated as the precipitation for the year, and then the slate wiped off and a new addition commenced. A graphical representation of what is actually done is shown in fig. 5, which is constructed from fig. 4, by simply making the initial ordinate at the first of each year zero. It is evident that fig. 5 represents correctly no natural phenomenon. Nature does not balance its books on the first of January, or stop work and take a fresh start. But fig. 6, which is prepared from fig. 5 by simply connecting the summits of the last ordinates of the different years, represents what is done to obtain the rainfall line in fig. 2. That this line represents no natural phenomenon is clear. It might be useful for conveying an idea, but a comparison of figs. 4, 5, and 6 shows that the idea which is conveyed is erroneous; hence, the comparison, attempted to be made in fig. 2 is hasty and illogical.

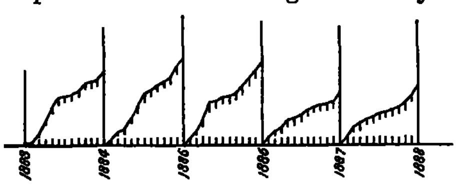

FIG. 5.

As any comparison of things which are incomparable must usually lead to erroneous conclusions, and as the comparison of a continuous record with a discontinuous one, without eliminating the element of discontinuity is fallacious in principle, hence, as an essential preliminary to a comparison between the level of Great Salt Lake and the precipitation, it is necessary to obtain some record of the rainfall which shall be continuous.

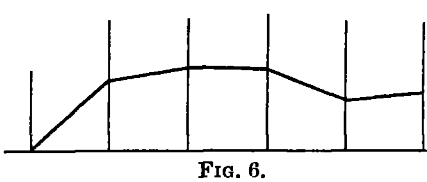

FIG. 6.

The quasi automatic record previously suggested is probably utterly impracticable; a rain gage could not be constructed in which no losses would occur for an indefinite period, and even if this practical difficulty were overcome there are the insuperable theoretical obstacles, that the rain gage must be indefinitely large and the recording sheet infinitely wide. These last considerations are those which from this point of view require the records of the rainfall to be kept as they now are. But whatever might be the practical difficulties which would arise in actual construction, it is perfectly possible to devise an apparatus that will entirely avoid the theoretical difficulties mentioned, and keep automatically a continuous record of the rainfall. If it be assumed that from the rain gage there is continuously allowed to escape a quantity of water equal to the mean precipitation, then the size of the rain gage required to hold all the rainfall for an infinite period becomes finite and comparatively small, and the trace made by the moving pencil operated by a float in such a gage would be contained within the limits of a sheet of paper of finite and moderate width, and a continuous record without breaks in its continuity could be kept.

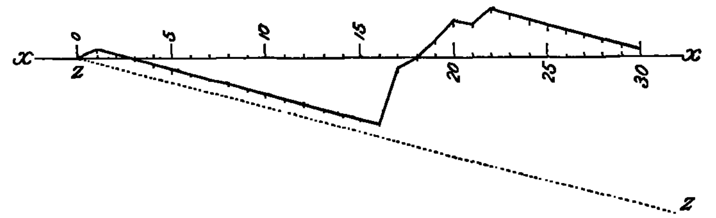

FIG. 7.

An approximation to such a record, prepared from the same data as were used in making fig. 3, is shown in fig. 7. The great difference between these two diagrams is that the lines which are horizontal in fig. 3 incline downward in fig. 7, while those which incline upward in fig. 3 are flatter or even incline downward in fig. 7. The reason is obvious; during the whole period the escape of the water representing the mean precipitation from the hypothetical rain gage imparts to the float in it a downward movement, which is partially or wholly counteracted or even reversed as soon as the rainfall enters the gage. The base line or axis of x, in fig. 7, represents the line of mean precipitation, p p, in fig. 3, and the ordinates in fig. 7 are the distances from the line of mean precipitation to the quasi trace in fig. 3. The quasi trace in the hypothetical automatic record in fig. 7 may evidently rise above or fall below the axis of x. If the rainfall exceed the mean precipitation, the trace will rise above the axis of x, while if the reverse be true, it will fall below it; and if the average precipitation during the entire period under consideration is equal to the mean or normal precipitation, the last ordinate for that period will be equal to the first. In making such a diagram as shown in fig. 7 it will usually be convenient to take the ordinate of the quasi trace at the origin of coordinates, as zero, because the true position of the line of mean or normal precipitation is as yet unknown. The line of mean or normal precipitation in such a diagram will be parallel to the axis of x, and its most probable true position will be that which makes the sum of the deviations of the trace above it equal to the sum of the deviations below it, so that it has a symmetrical relation to the quasi trace. Further, if through any point of the quasi trace a straight line, z z, be drawn, making with the axis of x an angle which corresponds to the mean precipitation, then the vertical distances from this line to the quasi trace give the total precipitation for the corresponding dates. In this case, as in the preceding one, the quasi trace represents an integration, and the length of the ordinate at the end of each interval can be obtained numerically by subtracting from the total precipitation for that interval the corresponding mean precipitation and adding the difference to the initial ordinate, both addition and subtraction being, of course, algebraic.

An approximate diagram of such a quasi trace, prepared from the observations made by the United States Weather Bureau at Salt Lake City, given in the following table, is shown in the upper full curve, A, of fig. 8:

In this diagram the precipitation which fell during each month is regarded as having fallen uniformly throughout

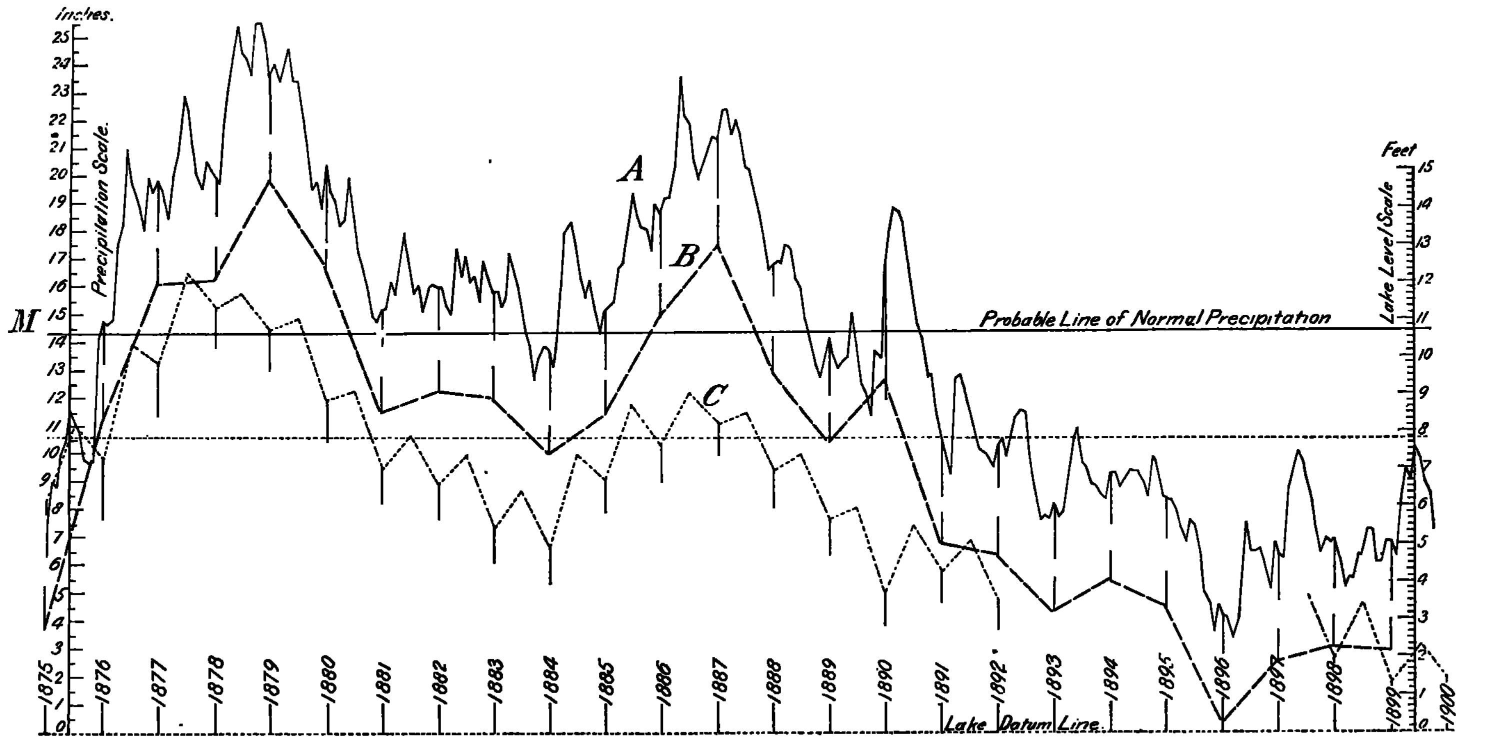

FIG. 8.

the entire month, an assumption required by the scale of the diagram. The normal precipitation is for convenience taken throughout as 1.35 inch per month, or 16.2 inches per annum.

Monthly and annual precipitation, Salt Lake City, Utah, from 1874 *to* 1899, *in inches.*

Year.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Annual.
1874 ...	......	......	1.31[a]	.90	2.84	.74	2.42	1.68	.20	1.74	2.16	.73	14.67
1875 ...	3.05	.79	2.81	1.50	2.91	.90	1.01	.25	1.22	1.36	5.81	2.03	23.64
1876 ...	1.23	1.52	4.00	2.09	4.30	.09	.83	.92	.42	3.27	.81	1.80	21.28
1877 ...	.87	.38	2.93	2.14	3.49	.80	.02	.28	.90	2.41	1.02	1.11	16.35
1878 ...	1.07	3.49	2.54	2.63	2.50	.85	1.08	.81	3.15	1.89	.63	.11	19.75
1879 ...	1.87	.71	.67	3.26	.10	1.34	.07	.06	.01	1.62	.32	3.08	13.11
1880 ...	.29	1.02	.43	2.37	1.85	.01	.20	.74	.56	.40	1.17	1.90	10.94
1881 ...	1.24	2.44	.88	2.37	2.55	.28	.21	1.66	.43	2.19	1.44	1.24	16.93
1882 ...	1.50	.42	1.12	3.81	.26	2.24	.30	1.61	.37	2.89	.54	.92	15.98
1883 ...	1.47	.72	1.75	2.92	.98	.33	.10	.62	.13	2.24	1.78	1.20	14.24
1884 ...	.71	2.23	3.69	2.89	1.78	.33	.27	.73	1.91	.36	.50	2.12	17.52
1885 ...	1.48	1.56	.64	3.47[b]	2.49	2.67	.58	.90	1.29	.59	3.10	.92	19.69
1886 ...	1.91	1.36	2.60	4.42	.06	1.02	T.	.59	1.88	1.98	1.79	1.27	18.89
1887 ...	2.36	1.41	.35	1.87	.73	.37	1.23	.69	.55	.30	.25	1.55	11.66
1888 ...	1.52	1.22	2.18	.99	.34	.36	.24	.63	.51	.80	2.00	2.21	13.62
1889 ...	.73	.81	1.64	1.52	2.97	.01	.08	.92	.52	3.85	1.04	4.37	18.46
1890 .	3.07	2 05	1.12	.94	.16	.32	.02	.79	T.	1.44	T.	.42	10.33
1891 ..	.74	.76	4.66	1.49	.72	1.08	.47	.46	1.19	1.26	.90	2.19	15.92
1892 ...	1.61	.68	2.21	1.90	1.65	1.21	T.	.05	1.12	1.58	.72	2.35	14.08
1893 ...	.82	1.64	2.68	2.72	1.68	.04	1.19	.71	1.30	1.02	1.18	2.37	17.35
1894 ...	1.31	.88	1.73	1.67	1.22	1.38	0.82	.87	2.87	1.01	.28	1.28	15.27
1895 ...	1.32	.85	.81	.73	2.29	.99	.42	.02	.95	.24	2.44	.89	11.95
1896 ...	1.26	.69	1.99	2.53	3.67	.25	1.35	1.47	.52	.70	3.15	.84	18.42
1897 ...	1.16	3.81	2.20	2.00	.98	.52	.69	.33	.48	1.91	1.19	1.47	16.74
1898 ...	.58	.38	1.71	1.30	4.19	1.45	.18	1.35	.15	1.57	1.95	1.28	16.09
1899 ...	.84	2.98	2.93	.81	2.59	.96	.42	1.06	T.	......	......	......	12.59
Sums .	34.01	34.75	51.58	55.25	49.30	20.66	14.20	20.15	21.63	38.12	36.17	39.65	402.88
Averages	1.36	1.39	1.98	2.12	1.90	.79	.55	.78	.83	1.52	1.45	1.59	16.18

[a] 12 days. [b] 28 days. T. indicates trace.

The line, *M*, gives the approximate position of the line of normal precipitation for the period of observation. It is very evident, however, that the correct determination of even an approximately true position of this line requires data covering a longer period than the observations afford.

There is no reason to suppose that the quasi trace, *A*, shown in fig. 8 is exceptional in character, and its general resemblance to a compound wave curve is obvious. Of course, a trace plotted on a larger scale, when the daily precipitation could be plotted, would show even greater deviations from a simple curve. This, however, does not detract from the evident suggestion that the natural forces operative are essentially periodic in their nature. This has long been suggested, and it is apparent that a graphic representation like that under consideration enables such forces, if they in fact exist, to be conveniently studied.

The effect of assumptions made in platting is indicated in fig. 8, which shows two different plattings of the same phenomena. The upper line in this diagram is the quasi trace; the lower or heavy dash line, *B*, is for the same period, but in it it is assumed that the rainfall in any one year is uniformly distributed throughout the year. The lack of character and essential detail in the lower line is very apparent, and it is evident that, if correct impressions are to be obtained, this detail is important. It is obvious that a diagram that shows the diurnal or even the hourly precipitation would be preferable to either of those under consideration.

The lower or dotted line in fig. 8, *C*, shows the level of Great Salt Lake platted from the data given in fig. 2. The general parallelism of lines *A* and *E* is apparent, and while the arbitrary scale for plotting the lake level was selected with a view to showing the general similarity to the best advantage, a comparison of fig. 8 with fig. 2 shows that this general correspondence actually exists.

The level of Great Salt Lake depends upon the precipitation and evaporation taking place throughout the whole extent of its drainage basin. Precipitation and evaporation are counteracting. Evaporation is certainly not a constant quantity, and possibly no more constant than precipitation The precipitation at Salt Lake City does not accurately represent that which occurs throughout the entire basin. The showers and storms throughout this area are frequently local in their character. Then while the diversion of the waters of the affluents of the lake for irrigation can not be regarded as the dominant factor which determines its level, it is a factor which may and probably does have some, possibly a considerable, effect on the lake level. Further, both the lines *A*, and *C*, in fig. 8, are approximations, and absolutely correct diagrams might give somewhat different results. There may be other operative causes than those just mentioned, but these are apparently sufficient to explain why a divergence between the two lines (possibly a greater divergence than that found) might be expected.

A deduction, that evidently might be drawn from the general parallelism of these lines, is that the factor of the rainfall, approximately shown in fig. 8, is of great, possibly dominating climatic importance. It is true that such deduction might prove to be erroneous and the parallelism be a mere accidental coincidence. This is a question, which can only be solved by further observation, and, pending such crucial test, the force of the obvious suggestion remains. Another obvious inference, deducible from the general parallelism of these lines, is that the fluctuations of the level of the lake, in the past, indicate similar fluctuations in this function of the precipitation. It ought from this consideration to be inferred that among the operative forces, if periodic, there are some of very long period, apparently longer than half a century, which have considerable effect.

That the fluctuations in the level of Great Salt Lake would, to some extent, affect the condition of the surrounding country might, for *a priori* reasons, be expected. The fall of the lake would lower the drainage level, and thus reduce the height of the underground water and the saline contents of the soil. The fact seems to be that since the country was settled in 1847 the character of the vegetation in the lands west of Salt Lake City has changed, the grasses being replaced by greasewood and other salt resisting plants. Doubtless, the present condition of these lands is unnatural and much affected by the acts of man. Overpasturing, canal seepage, and excessive irrigation, have all contributed their part toward producing the present condition. This, however, does not touch the fact that when the valley was settled the waters of the lake were low, that they rose steadily for more than a quarter of a century, and have since been receding. The total rise and fall being about thirteen feet or more. Nor does it affect the facts that these lands were less saline, when the country was settled, that their salinity as indicated by the vegetation increased before there was any irrigation, and that of late years their character has much improved. These salient facts are entirely independent of the acts of man. It is unfortunate that slow natural changes, like those under consideration, are difficult tc appreciate. After a series of years the observer may indeed notice an apparent change, but in the absence of full notes of prior observations recourse must necessarily be had to more or less uncertain recollections, perchance tinctured by preconceived opinions; so that the conclusions must always be unsatisfactory. That these changes might all be explained by the rise and fall of the lake is obvious, but it must be remembered that the lands referred to are not those immediately adjacent to it, but were at least four or five miles distant from its shores when it was highest, and that their surface was, at that time, several feet above the lake.

When it is said that the level of the underground water would be raised by a rise in the waters of Great Salt Lake and lowered by their fall only one factor of the change which takes place has been considered. If the level of the lake remained the same those natural forces which produce the fluctuation in its level would change the gradient of the underground water, for this gradient depends upon an equilibrium of supply and discharge, as controlled by frictional resistances, and any increase in the supply or discharge changes the gradient. The movement of water in soils is not a simple, but a dual phenomenon. If the soil is not surcharged with water, the movement results from the capillary forces explained by Mr. Briggs in his paper on the Movement and Retention of Water in Soils, published in the Year Book of the Department of Agriculture for 1898; but when, on the other hand, the soil is surcharged with water under pressure, its movements are controlled largely, if not wholly, by frictional resistances. These frictional resistances are functions of the pressure or head, which vary with the pressure, and the movements of the water are asymptotic in character. To illustrate their character, assume a water-tight vessel to be divided into two parts by a porous partition resembling a thin sheet of sand or clay, and that one of the parts is filled with water, which percolates through the partition into the other; then since the flow of water depends upon the head and decreases as the head diminishes, vanishing only when the head becomes zero, it follows that if no other force were operative it would take an infinite period before the water on both sides of the partition stood at the same level. Practically if the partition were very thin, a sensible agreement of level might result in a comparatively short space of time; but as from the increased frictional resistance the flow decreases very rapidly as the thickness of the partition increases, it requires very long periods of time with a thick partition to reduce the gradient of the flow to even sensible horizontality. For this reason the underground waters usually have high gradients.

In wet seasons the quantity of underground water to be discharged will be increased and in dry diminished, and the gradient flatten or steepen; but since from the slowness of the discharge it cannot be assumed that all the increase of the underground water in any one year, even when the level of the outlet remains constant, is discharged during that year, it is probable that a succession of wet or dry years causes the level of the underground waters, even when the point of discharge remains the same, to fluctuate as does the level of Great Salt Lake.

When the soil is not surcharged with water under pressure and the movement of the soil water depends upon capillary forces, the same results would apparently follow, for these are relatively weak forces.

Assuming that at a certain depth below the surface the moisture in the soil remains constant, while above it the soil is wet by precipitation and dried by evaporation; then there is apparently no reason why the level of normal soil moisture should remain constant. If wet years were succeeded by wet years, this level should rise, and if dry years followed dry years it should fall, just as the level of Great Salt Lake does, these oscillations of level being largely influenced by the accumulated deviation from the mean precipitation.

If the level of this normal soil moisture has, as it might well have, some influence on vegetation, then it is apparent that it becomes a climatic feature of some importance.

These *a priori* conclusions can of course merely establish probabilities, which may or may not be verified by observation and experiment, and they are only valuable as indicating along what lines observation and experiment might be made, in the hope of obtaining important results. Obviously, if it be conceded that the fluctuations of the level of Great Salt Lake are typical of climatic conditions which may prevail everywhere to a greater or less extent, the first step toward the study of these conditions would be the tabulation of the departures of the total precipitations from the mean or normal precipitation.

FOG STUDIES ON MOUNT TAMALPAIS: NUMBER 5—WRECK OF THE PACIFIC MAIL STEAMSHIP RIO DE JANEIRO.[1]

By ALEXANDER G. MCADIE Forecast Official.

On the morning of Friday, February 22, 1901, the Pacific

[1] The publication of No. 4 is delayed by nonarrival of half-tone plates. It may be expected in the March REVIEW.—ED.